DOCUMENT RESUME

ED 238 719 SE 043 740

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TITLE Of Feedback, Noise, and Clarion Calls: Preserving the Quality of Engineering Education.
PUB DATE Nov 83
NOTE 17p.; Keynote remarks by the President of Exxon Research and Engineering Co. at the American Society for Engineering Education (November 5, 1983).
PUB TYPE Speeches/Conference Papers (150) -- Viewpoints (120)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Science; *Computer Science; *Educational Quality; *Engineering Education; Government Role; Higher Education; *Industry; Labor Needs; Labor Supply; Policy Formation; Productivity; *School Business Relationship; Science Education; *State Action; Technology
IDENTIFIERS *Industrial Policy; New Jersey

ABSTRACT

Although times seemed ripe for far-reaching initiatives to safeguard the quality of engineering education, current political noise about the issue threatens to drown out the engineering community's message. However, the engineering community's theme should be that economic growth in a modern economy, that industrial policy, is based first and foremost on people, including a cadre of scientists/engineers trained to high standards of technical excellence; and such a cadre will not endure unless engineering schools are healthy. Renewed support for action is available, but the question is whether the engineering community will make its clarion calls heard and will receive an adequate share of the new funds becoming available. The question of industrial policy at federal and state levels needs to be considered, particularly in states where new paradigms linking industry and the academic science and engineering communities in the service of economic growth based on new technology are being created. This can be illustrated by recommendations of the New Jersey Governor's Commission on Science and Technology. Two related issues where industry and engineering schools share responsibility should also be considered, namely, concern aroused by the failure to match engineering supply/demand and the success in using computing technologies to boost engineering productivity. (JN)

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OF FEEDBACK, NOISE, AND CLARION CALLS: PRESERVING THE QUALITY OF ENGINEERING EDUCATION

KEYNOTE REMARKS BY
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PRESIDENT, EXXON RESEARCH AND ENGINEERING COMPANY
AT THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
NOVEMBER 5, 1983

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Highlights — Page(s)

These are volatile times for engineering education. Only a few weeks ago, the times seemed ripe for far-reaching initiatives for safeguarding the quality of engineering education. 1

There is renewed support for action in support of technology and even technological fixes. The question is whether the engineering community will make its clarion calls heard and will receive an adequate share of the large new funds becoming available. 5

The competition for funds is frustrating for the engineering community, because on their face the engineering community's problems are so manageable--requiring perhaps a mere $5 per person in the U.S. 6

It is in the states where most of the action is in industrial policy. It is these "laboratories of democracy" that are creating new paradigms linking industry and the academic science and engineering communities in the service of economic growth based on new technology. 7

The point can be illustrated from the recommendations of the New Jersey Governor's Commission on Science and Technology. 7

The New Jersey Governor's Commission proposes a system of Advanced Technology Centers. The goal would be to create a critical mass--sufficient concentrations of high quality academics, graduate students, research programs, and associated industry to set off high quality economic chain reactions. 9

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LET ME BEGIN BY COMPLIMENTING YOU OF THE ASEE FOR YOUR UNCANNY SENSE OF TIMING. WITH YOUR FOCUS ON PERSONAL COMPUTING, YOU HAVE MADE THIS MEETING THE CAPSTONE OF ONE OF THE MOST EVENTFUL WEEKS IN PERSONAL COMPUTING THAT I CAN REMEMBER. TEXAS INSTRUMENTS WITHDREW FROM THE HOME COMPUTER MARKET AND IBM NOT ONLY ACKNOWLEDGED, BUT ANNOUNCED THE "PEANUT." THE SOFTWARE IMPLICATIONS FLEW THICK AND FAST. THESE ARE INDEED EVENTFUL TIMES NOT ONLY FOR THE COMPUTING INDUSTRY BUT PARTICULARLY FOR USERS.

ON A MORE SOMBER NOTE, THESE ARE ALSO VOLATILE TIMES FOR ENGINEERING EDUCATION. ONLY A FEW SHORT WEEKS AGO, THE TIMES SEEMED RIPE FOR FAR-REACHING INITIATIVES TO MEET THE GOAL THAT THE ASEE HAS BEEN SO VIGOROUSLY PURSUING IN RECENT YEARS--SAFEGUARDING THE QUALITY OF ENGINEERING EDUCATION BY CORRECTING THE GRIEVOUS SHORTAGE OF ENGINEERING FACULTY AND BY REFURBISHING ANTIQUATED LABORATORIES. THE TIMES SEEMED RIPE BECAUSE OF THE WIDESPREAD POLITICAL INTEREST IN STRENGTHENING U.S. INDUSTRY TO DO BETTER BATTLE AGAINST FOREIGN COMPETITION, TO PROMOTE ECONOMIC GROWTH, AND TO CREATE JOBS. DISCUSSION ABOUT THIS MATTER HAS GONE UNDER SUCH RUBRICS AS "RE-INDUSTRIALIZATION" AND, MORE COMMONLY IN RECENT MONTHS, "INDUSTRIAL POLICY." UNFORTUNATELY, OVER THE PAST YEAR, THE DISCUSSION HAS PASSED RAPIDLY TO DEBATE, AND THEN SLOGANEERING. NOW WE HAVE ENTERED A PHASE WHERE THE POLITICAL NOISE ABOUT THE ISSUE THREATENS TO DROWN OUT THE MESSAGE THAT THE ENGINEERING COMMUNITY HAS BEEN FEEDING INTO THE SYSTEM. A PRECIOUS OPPORTUNITY IS IN DANGER OF BEING LOST.

ALL IS NOT YET LOST, BUT IT IS A TIME FOR CLARION CALLS FROM THE ASEE AND THE REST OF THE COMMUNITY. THEIR THEME SHOULD BE THAT ECONOMIC GROWTH IN A MODERN ECONOMY--THAT INDUSTRIAL POLICY -- IS FIRST AND FOREMOST PEOPLE, INCLUDING A CADRE OF SCIENTISTS AND ENGINEERS TRAINED TO HIGH STANDARDS OF TECHNICAL EXCELLENCE. AND SUCH A CADRE WILL NOT ENDURE UNLESS THE ENGINEERING SCHOOLS ARE HEALTHY.

IF COMMISSIONS AND CONFERENCES WERE KINGS WE WOULD HAVE RESOLVED THE EDUCATIONAL PROBLEM LONG AGO. THE ASEE HAS OF COURSE TAKEN A LEAD ROLE IN DRAWING ATTENTION TO THE PLIGHT OF THE ENGINEERING SCHOOLS THROUGH ITS SPONSORSHIP OF THE PROJECT ON THE ENGINEERING FACULTY SHORTAGE. MORE THAN A YEAR AGO, AT THE REQUEST OF MIT PRESIDENT PAUL GRAY, I CHAIRED THE NATIONAL ENGINEERING ACTION CONFERENCE IN SUPPORT OF THE SAME GOAL. MANY OTHER GROUPS HAVE SPOKEN OUT AS WELL. AND THE LEADERSHIP DID LISTEN AND MUCH, BUT NOT ENOUGH, ACTION FOLLOWED.

POLITICAL WILL AND SOCIAL PURPOSE ARE FICKLE THINGS IN THE UNITED STATES IN THIS LAST QUARTER OF THE 20TH CENTURY. THE SIGNS ARE THAT THE LEADERSHIP MAY DISSIPATE THE ENERGY OF ITS REALIZATION IN LOGIC CHOPPING ABOUT "INDUSTRIAL POLICY." A WELL-KNOWN WRITER ON THE TOPIC, ROBERT REICH, RECENTLY OBSERVED THAT THE TERM HAS PASSED RAPIDLY FROM OBSCURITY TO MEANINGLESSNESS WITHOUT EVER ACHIEVING COHERENCE. EVEN THOUGH MEMBERS OF CONGRESS HAVE FILED MORE THAN 200 BILLS RELATED TO THE ISSUE, INTEREST SHOWS EVERY SIGN OF HAVING PEAKED.

WHAT HAS PROVED A DEVASTATING CRITICISM IS THAT MANY VERSIONS OF INDUSTRIAL POLICY PRESUPPOSE THAT A GOVERNMENT AGENCY CAN PICK WINNERS AND LOSERS AMONG INDUSTRIES, COMPANIES, AND TECHNOLOGIES. THE TERM HAS BECOME A HIGHLY CHARGED CODE WORD FOR "NATIONAL PLANNING. AS A RESULT, WALTER MONDALE HAS RENOUNCED THE TERM. CHARLES SCHULTZE, WHO WAS ECONOMIC ADVISOR TO PRESIDENT CARTER, ALSO DERIDES "INDUSTRIAL POLICY" AS A POLICY IN SEARCH OF A PROBLEM; HE BLAMES THE WOES OF THE MANUFACTURING INDUSTRIES ON THE ECONOMIC CYCLE, NOT ON POOR INDUSTRIAL POLICY. AND MANY OTHERS ON THE WASHINGTON SCENE ARE COMING TO AGREE THAT THE ISSUE WILL DISAPPEAR IN THE EUPHORIA OF ECONOMIC RECOVERY; IT WILL NOT BE AN ISSUE IN THE 1984 NATIONAL ELECTIONS.

WILL THE CASE FOR SAFEGUARDING THE QUALITY OF U.S. ENGINEERING EDUCATION DISAPPEAR ALONG WITH IT? CLEARLY, THE ENGINEERING COMMUNITY CANNOT AFFORD TO LET THAT HAPPEN.

ORGANIZATION

IN THE REST OF MY REMARKS THIS AFTERNOON, I'LL EXPLORE THIS QUESTION AS IT APPLIES BOTH AT THE FEDERAL AND THE STATE LEVELS. THEN I'LL TURN AWAY FROM GOVERNMENT AND BRIEFLY CONSIDER TWO RELATED ISSUES WHERE INDUSTRY AND THE ENGINEERING SCHOOLS SHARE RESPONSIBILITY. THE FIRST IS THE CONCERN AROUSED BY OUR FAILURE TO MATCH ENGINEERING SUPPLY AND DEMAND. THE OTHER BUILDS ON YOUR CONFERENCE THEME, FOR IT CONCERNS OUR SUCCESS IN USING COMPUTING TECHNOLOGIES TO BOOST ENGINEERING PRODUCTIVITY. BOTH THESE ISSUES BEAR ON THE COMMUNITY'S COMPETENCE AND CREDIBILITY--

WHICH ARE CRITICAL FACTORS IN SOUNDING CREDIBLE CALLS THAT RISE ABOVE THE NOISE.

FEDERAL AND STATE INDUSTRIAL POLICY

RETURNING TO THE WASHINGTON SCENE, LET ME EMPHASIZE THAT I BELIEVE THAT "INDUSTRIAL POLICY" WILL CEASE TO BE A NAME BEFORE AT LEAST ITS ELEMENTS CEASE TO BE AN ISSUE. THE TERM RECALLS WHAT MARK TWAIN ONCE SAID ABOUT WAGNER'S OPERA: IT'S GOT TO BE BETTER THAN IT SOUNDS. I AM OF COURSE NOT SPEAKING ABOUT PICKING WINNERS AND LOSERS BUT ABOUT THE MYRIAD MICROECONOMIC STEPS THAT THE FEDERAL GOVERNMENT HAS TAKEN TO SUPPORT VARIOUS SECTORS IN THE ECONOMY--EQUAL OPPORTUNITY GRANTS AND LOW-INTEREST TUITION LOANS; SUPPORT FOR ALMOST HALF THE NATION'S R&D, INCLUDING ACADEMIC RESEARCH; AUTO AND STEEL IMPORT QUOTAS; THE CHRYSLER RESCUE; "WINDFALL PROFITS TAXES" ON THE OIL INDUSTRY; AND SO ON. TO ARGUE THAT WE SHOULD NOT HAVE SUCH POLICIES IS LIKE ARGUING THAT WE SHOULD NOT HAVE FISCAL AND MONETARY POLICIES--ONE WAY OR ANOTHER, WILLY-NILLY, WE HAVE THEM. TOGETHER THEY ARE A DEFACTO INDUSTRIAL POLICY.

PERHAPS MORE TO THE POINT, DESPITE THE USUAL BLAME ON THE STRONG DOLLAR, ECONOMIC RECOVERY WILL NOT ERASE THE MANIFEST SIGNS OF U.S. WEAKNESS IN THE FACE OF INTERNATIONAL COMPETITION, ANY MORE THAN IT WILL ERASE THE PROBLEMS OF THE ENGINEERING SCHOOLS. AND THE PUBLIC SENSES THESE FACTS; IT IS READY TO LISTEN TO PROPOSALS; THE SUCCESS OF THE JAPANESE IN PENETRATING OUR MARKETS HAS MADE A DEEP IMPRESSION. FOR EXAMPLE, RECENT

OPINION DATA SHOW THAT MORE THAN A THIRD OF ALL AMERICANS BELIEVE THE U.S. HAS FALLEN BEHIND OTHER COUNTRIES IN TECHNOLOGY. AT THE SAME TIME, OVER 70 PERCENT BELIEVE THAT TECHNOLOGY DOES MORE GOOD THAN HARM, TEN PERCENTAGE POINTS UP FROM THE PREVIOUS YEAR.

THERE IS RENEWED SUPPORT FOR ACTION IN SUPPORT OF TECHNOLOGY, AND EVEN TECHNOLOGICAL FIXES. ACTION WILL BE FORTHCOMING, EVEN THOUGH IT WON'T BE NEATLY PACKAGED AS "INDUSTRIAL POLICY." AGAIN, THE QUESTION IN THIS VOLATILE SITUATION IS WHETHER THE ENGINEERING COMMUNITY WILL MAKE ITS CLARION CALLS HEARD AND WILL RECEIVE AN ADEQUATE SHARE OF THE LARGE NEW FUNDS BECOMING AVAILABLE FOR SCIENCE AND TECHNOLOGY.

AS AN EXAMPLE OF THE TRENDS, WE HEARD THE PRESIDENT BEGIN THE YEAR BY SUGGESTING THE TECHNOLOGICAL FIX EMBODIED IN A "STAR WARS" MISSILE DEFENSE. THE INDICATIONS ARE THAT IN THE FISCAL 1985 BUDGET, THE ELECTION YEAR BUDGET, WE SHALL SEE PROPOSALS FOR SPLASHY "NATIONAL" PROJECTS COMPARABLE IN MANY WAYS TO THOSE UNDERTAKEN BY THE JAPANESE MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY, OR MITI.

ALREADY IN FISCAL 1984, THE DEFENSE DEPARTMENT WILL SPEND SOME $83 MILLION ON THE CONTINUING VERY HIGH SPEED INTEGRATED CIRCUIT PROJECT AND PROBABLY SOME $220 MILLION ON THE ADVANCED MANUFACTURING TECHNOLOGY PROGRAM. LAST APRIL, DOD ANNOUNCED THAT IT EXPECTS TO SPEND OVER $750 MILLION IN THE NEXT SEVEN OR MORE YEARS ON THE "STRATEGIC COMPUTING AND SURVIVABILITY PROGRAM." THIS PROGRAM IS DESIGNED TO PRODUCE A GENERATION OF SMART "FIRE-AND-FORGET" WEAPONS SYSTEMS, BUT IT FOCUSES ON

TECHNOLOGIES THAT STRONGLY RESEMBLE THOSE BEING ADDRESSED IN THE SUPERCOMPUTER AND FIFTH GENERATION COMPUTER PROJECTS ANNOUNCED BY JAPAN'S MITI. OVERALL, DOD'S R&D BUDGET FOR FISCAL 1984 INCREASED BY NEARLY 30 PERCENT COMPARED TO THE PREVIOUS YEAR, AND MORE INCREASES ARE EXPECTED IN 1985. THE NATIONAL SCIENCE FOUNDATION HAS DISCLOSED A PLAN FOR MAKING SUPERCOMPUTERS MORE WIDELY AVAILABLE TO ACADEMIC SCIENCE. AS FOR THE ENERGY DEPARTMENT, WE ARE BEGINNING TO HEAR PROPOSALS FROM THE PHYSICS COMMUNITY FOR A $2 TO $6 BILLION "DESERTRON," A PARTICLE ACCELERATOR SO HUGE THAT IT COULD ONLY BE BUILT IN A DESERT. AND NASA HAS ITS LONG-STANDING PROPOSAL FOR AN $8 BILLION SPACE STATION WHICH THE ADMINISTRATION IS NOW CONSIDERING SERIOUSLY. SENATOR GLENN HAS ALREADY ENDORSED THE CONCEPT.

OBVIOUSLY, EVEN IF THERE IS LATENT PUBLIC SUPPORT FOR ACTION, THERE IS LITTLE GUARANTEE THAT IT WILL FOLLOW THE RIGHT PRIORITIES. THE COMPETITION FROM, AND FOR, THE DIFFERENT CONSTITUENCIES IS INTENSE. HOW WILL THE ENGINEERING COMMUNITY FARE AGAINST THE MUCH BROADER CONSTITUENCY OF PARENTS WHO ARE BEING PRODDED INTO A STATE OF ALARM ABOUT WHETHER THE SCHOOLS ARE MAKING THEIR CHILDREN SCIENTIFICALLY AND MATHEMATICALLY LITERATE? THE COMPETITION IS FRUSTRATING FOR THE ENGINEERING COMMUNITY, BECAUSE ON THEIR FACE THE ENGINEERING COMMUNITY'S PROBLEMS ARE SO MANAGEABLE COMPARED TO SO MANY OTHERS. AS DEAN DAN DRUCKER HAS JUST POINTED OUT IN <u>SCIENCE</u> MAGAZINE, THEY MAY REQUIRE A MERE $5 PER PERSON IN THE U.S.

Engineering education should obtain further help from Washington. But in fact it is in the <u>states</u> where most of the action is in industrial policy -- and where most of the opportunity and where most of the reponsibility of the engineering community should lie. To use Justice Brandeis's phrase, it is these "laboratories of democracy" that are creating new paradigms linking industry and the academic science and engineering communities in the service of economic growth based on new technology. It is there that the clarion calls of the community must be heard loudest. For it is there, too, as relative prosperity returns, that the momentum toward greater support for engineering education could be lost.

Let me illustrate from my own experience in serving on the New Jersey Governor's Commission on Science and Technology during the past year. The Commission includes representatives from higher education, labor, government, and industry. I should note here that I had the pleasure of serving on the Commission with Ken Rogers, President of Stevens. The Governor's charge to us was to find ways for promoting faster and better economic growth by examining the state's business climate, financing schemes, promotional activities, and the interface between business and the universities. The models invoked were of course such phenomena as Silicon Valley, Route 128, and the Research Triangle.

In New Jersey we are frankly playing catch-up. Much of what the Commission will shortly recommend formally to the

GOVERNOR IS ALREADY BEING PROPOSED OR TRIED IN VARIOUS OTHER STATES. I REALIZE THAT MAY SEEM APPROPRIATE FOR A STATE WHERE EVERYONE AND EVERYTHING SEEMS TO GO, AND GO THROUGH, WITHOUT ACTUALLY SEEMING TO STAY OR BELONG. ONLY NEW JERSEY COULD BE THE FULL TIME HOME OF A PROFESSIONAL FOOTBALL TEAM KNOWN AS THE NEW YORK GIANTS. STILL, IN THEIR APPLICATION THE COMMISSION'S RECOMMENDATIONS ARE CERTAIN TO REFLECT THE PARTICULAR NATURE OF THE STATE'S POLITICS, INDUSTRY, AND LEADERSHIP.

WITH REGARD TO THE ENGINEERING SCHOOLS, ONE OF THE COMMISSION'S INTRIGUING PSEUDO-DISCOVERIES WAS THAT NEW JERSEY PRODUCES RELATIVELY FEW ENGINEERS. IN PARTICULAR, THE ELECTRICAL ENGINEERING DEPARTMENTS ARE SMALL, THIS DESPITE THE LONG PRESENCE IN THE STATE OF A SIZABLE COMPUTING AND COMMUNICATIONS INDUSTRY, WITH MAJOR UNITS OF AT&T, ITT, LOCKHEED, AND RCA. BUT NEW JERSEY COLLEGES AND UNIVERSITIES HAVE NOTABLE STRENGTHS--FOR EXAMPLE, CERAMICS ENGINEERING, POLYMER PROCESSING, AND FUSION ENERGY. ONE PROGRAM THAT AROUSED GREAT INTEREST WAS THE PROJECT HERE AT THE STEVENS INSTITUTE TO INTEGRATE PERSONAL COMPUTING IN ALL PHASES OF ENGINEERING EDUCATION, FROM CALCULUS TO THE HUMANITIES. BUT, AS A RULE IN NEW JERSEY, THERE IS A CLEAR DISPARITY BETWEEN ACADEMIC AND INDUSTRIAL RESOURCES BOTH IN SCOPE AND CONTENT.

AS A RESULT, THE COMMISSION WILL RECOMMEND THAT THE STATE INCREASE ITS ENGINEERING PROGRAMS, WITH EMPHASIS ON BUILDING STRONGER GRADUATE PROGRAMS. THE MEANS, ULTIMATELY, WOULD INCLUDE 200 MERIT-BASED FELLOWSHIPS AND STATE-OF-THE ART LABORATORY FACILITIES. THE COMMISSION WILL RECOMMEND CALLING ON

THE PRIVATE SECTOR TO PAY PART OF THE COST FOR THE FACILITIES, WITH TAX CREDITS AS THE SWEETENER. BEYOND EDUCATION, THERE IS THE QUESTION OF HOW TO FOSTER INNOVATION IN THE SERVICE OF ECONOMIC GROWTH. ECONOMIC GROWTH BASED ON NEW TECHNOLOGY OCCURS ONLY WHEN KNOWLEDGE IS YOKED WITH THE SPIRIT OF ENTERPRISE. RAISING THAT SPIRIT MEANS CREATING AN ENVIRONMENT WHERE ACADEMIC AND INDUSTRIAL RESEARCHERS JOIN FORCES EASILY, WHERE IDEAS FLY BACK AND FORTH NATURALLY, WHERE BUDDING ENTREPRENEURS TRANSLATE LEADING-EDGE RESEARCH QUICKLY INTO NEW TECHNOLOGIES, NEW BUSINESSES, AND NEW JOBS. ALTHOUGH THE PROCESS IS MAGICAL IN ITS EFFECTS, THERE IS NO MAGIC FORMULA FOR CALLING IT TO LIFE. NEVERTHELESS, THE CHALLENGE TO MY OWN TASK FORCE WAS TO LOOK FOR SPECIFIC MECHANISMS THAT WOULD HELP PROMOTE SUCH AN ENVIRONMENT. HERE ARE THE INITIATIVES THAT WE ARE RECOMMENDING.

THE FIRST IS TO ESTABLISH SEVERAL NEW "ADVANCED TECHNOLOGY CENTERS" LIKE THE COOPERATIVE RESEARCH CENTERS PROMOTED BY THE NATIONAL SCIENCE FOUNDATION. A FINE CURRENT EXAMPLE IS THE RUTGERS CERAMICS RESEARCH CENTER, WHICH SOME 14 BUSINESSES PAY $30,000 APIECE TO SUPPORT EACH YEAR. LIKE MOST OF THE PROGRAMS THAT THE COMMISSION IS PROPOSING, THE GOAL OF THE ADVANCED TECHNOLOGY CENTERS WOULD BE TO CREATE A CRITICAL MASS--THAT IS, SUFFICIENT CONCENTRATIONS OF HIGH QUALITY ACADEMICS, GRADUATE STUDENTS, RESEARCH PROGRAMS, AND ASSOCIATED INDUSTRY TO SET OFF HIGH QUALITY ECONOMIC CHAIN REACTIONS. THE CENTERS WOULD FOCUS ON FIELDS WHERE THE STATE'S INDUSTRY IS, OR CAN BE, STRONG; NAMELY, BIOTECHNOLOGY, FOOD TECHNOLOGY, MATERIALS SCIENCE, HAZARDOUS WASTE MANAGEMENT, AND COMPUTING AND COMMUNICATIONS.

THE SECOND RECOMMENDATION OF OUR TASK FORCE IS TO ESTABLISH "INNOVATION PARTNERSHIPS." THIS PROGRAM WOULD PROVIDE MATCHING GRANTS OF BETWEEN $10,000 AND $250,000 TO INDIVIDUAL ACADEMIC RESEARCHERS PERFORMING RESEARCH IN NEW TECHNOLOGIES POTENTIALLY IMPORTANT TO THE STATE'S ECONOMY. SUCH A GRANT COULD BE A LOGICAL PRECURSOR TO AN ADVANCED TECHNOLOGY CENTER.

THE THIRD RECOMMENDATION IS A MODEST NETWORK OF "INCUBATION FACILITIES" -- THAT IS, LOW COST SPACE THAT UNIVERSITIES COULD OFFER SO THAT FLEDGLING COMPANIES CAN BE NEAR WHERE THE RESEARCH ACTION IS. FOR REASONABLE FEES, THE COMPANIES COULD ALSO SHARE ACCESS TO COMPUTER FACILITIES, LABORATORIES, AND THE LIKE.

THE FOURTH RECOMMENDATION IS A "TECHNOLOGY EXTENSION SERVICE" WITH THE MISSION OF SPEEDING THE SPREAD OF NEW TECHNOLOGIES TO SMALL AND MEDIUM SIZE COMPANIES. THE UNIVERSITIES WOULD PLAY A KEY ROLE IN THE SERVICE, FOR DIFFUSING TECHNOLOGY MEANS EDUCATING PEOPLE. THE SERVICE SHOULD ALSO BUILD ON THE BASE OF EXISTING PROGRAMS AT THE UNIVERSITIES, SUCH AS THE BUSINESS OUTREACH PROGRAMS HERE AT STEVENS AND AT THE NEW JERSEY INSTITUTE OF TECHNOLOGY.

FINALLY, OUR TASK FORCE IS RECOMMENDING THE CREATION OF A "NEW JERSEY ACADEMY OF APPLIED SCIENCES" WITH A CHARTER FROM THE STATE. THE PURPOSE OF THE ACADEMY WOULD BE TO SERVE AS A SOURCE OF OBJECTIVE TECHNICAL ADVICE FOR THE STATE GOVERNMENT, ASSUMING A ROLE COMPARABLE TO THE ONE PLAYED BY THE NATIONAL ACADEMY OF SCIENCE IN WASHINGTON.

OBVIOUSLY, A STATE REQUIRES MUCH MORE THAN THESE MECHANISMS TO INDUCE ECONOMIC GROWTH BASED ON TECHNOLOGICAL INNOVATION. THE REALLY TOUGH AND CRITICAL QUESTIONS RANGE MUCH FURTHER INTO THE POLITICAL QUICKSAND. THEY INCLUDE ALL THOSE DISINCENTIVES THAT THE STATE MUST REMOVE AND ALL THOSE INCENTIVES THAT THE STATE MUST ESTABLISH TO COMPETE WITH OTHER STATES FOR NEW INVESTMENT. THE COMMISSION DOES MAKE MANY RECOMMENDATIONS CONCERNING SUCH MATTERS AS VENTURE FINANCING, TAX AND REGULATORY POLICY, GENERAL EDUCATION, AND TRAINING. STILL, THE COMMISSION'S WORK IS THE JUST THE FIRST VOLLEY IN A LONG BATTLE. AND, AS I'VE SAID, IT IS AN INCREASINGLY UNCERTAIN BATTLE, GIVEN THE DECLINING CREDIBILITY OF IDEAS ASSOCIATED WITH "INDUSTRIAL POLICY." AS THE VARIOUS PARTIES TRY TO GALVANIZE SUPPORT IN THE COMING ELECTION YEAR, THE REAL TESTING WILL BEGIN.

ENGINEERING PERSONPOWER; PERSONAL COMPUTING

IN THE PROCESS, WE IN THE ENGINEERING COMMUNITY WILL NEED TO USE OUR PERSUASIVE POWERS TO KEEP SUCH DEBATE ON A PRODUCTIVE PATH. ANOTHER PIECE OF DISTRACTING NOISE TODAY IS THE ENGINEERING "PERSONPOWER" MISMATCH. THERE IS NO DOUBT THAT THE ENGINEERING SCHOOLS AND INDUSTRY ALIKE LOSE CREDIBILITY WHEN THEY FAIL TO MATCH UP THE ENGINEERING SUPPLY AND DEMAND. UNFORTUNATELY, THERE IS NO GOOD ANSWER. THE ASEE HAS DONE YEOMAN SERVICE IN CHARTING THE TRENDS. BUT THERE IS TOO MUCH DELAY BUILT INTO THE FEEDBACK LOOP. IN ARGUING THE MATTER, ONE IDEA TO STRESS IS HOW WELL AN ENGINEERING EDUCATION SUITS VARIETY OF NON-

ENGINEERING JOBS. AND PERHAPS ENGINEERING EDUCATION SHOULD LOOK AT WAYS TO INCREASE THE ABILITY OF YOUNG ENGINEERS TO MOVE FROM ONE ENGINEERING FIELD TO ANOTHER. PAST EXPERIMENTS WITH GENERAL ENGINEERING EDUCATION HAVE NOT WORKED WELL; PERHAPS IT IS TIME FOR ANOTHER LOOK AT THE ISSUE AND ALSO AT HOW TO PERSUADE EMPLOYERS TO HIRE ENGINEERS WITH GENERALIZED TRAINING.

THERE ARE OF COURSE OTHER POINTS TO EMPHASIZE IN TRYING TO BOLSTER THE CREDIBILITY OF ENGINEERING EDUCATORS. CERTAINLY, ONE OF THE MOST IMPORTANT IS HOW EDUCATORS HAVE TAKEN STEPS TO UTILIZE ADVANCED TECHNOLOGY TO INCREASE THE QUALITY OF ENGINEERING EDUCATION. SO AT THIS POINT I SHOULD APPLAUD YOUR FOCUS AT THIS CONFERENCE ON PERSONAL COMPUTING FOR THE ENGINEERING STUDENT. MY OWN CONVICTION IS THAT THE MOST IMPORTANT ROLE OF COMPUTING IS AS A SPUR TO INSIGHT AND CREATIVITY, RATHER THAN AS A MACHINE FOR ROTE DRILL AND SPEEDIER CALCULATION. IN THIS RESPECT, I WOULD EMPHASIZE THE PROGRAMMING TASK. PRE-PACKAGED PROGRAMS ARE OF COURSE IMPORTANT. BUT FOR THE ENGINEER PROGRAMMING OFFERS, AMONG OTHER THINGS, A FINE PARADIGM OF ENGINEERING ITSELF. THE FLOWCHARTING AND CODE DRAFTING COUNT AS DESIGN; THE EDITING TO GAIN PROGRAM SPEED COUNTS AS OPTIMIZATION; AND DEBUGGING COUNTS AS QUALITY CONTROL.

AT EXXON OUR OWN PERCEPTIONS ABOUT THE FUTURE OF COMPUTING MUST PARALLEL YOUR OWN. THE CLEAR TREND IS TOWARD EXTENSIVE LOCAL PERSONAL COMPUTING AVAILABLE FROM POWERFUL DESKTOP AND LABORATORY COMPUTERS AT THE ENGINEER'S FINGERTIPS. EVENTUALLY, THE HUB OF EXXON'S NEW COMPUTING SYSTEMS WILL BE

DESKTOP WORKSTATIONS OF EXTRAORDINARY POWER. IN ONE NETWORKED SYSTEM THEY WILL INTEGRATE ENGINEERING AND SCIENTIFIC COMPUTING; OFFICE AND ADMINISTRATIVE COMPUTING, INCLUDING WORD PROCESSING; INFORMATION MANAGEMENT AND RETRIEVAL; AND TEXT, DATA, GRAPHICS, AND VOICE COMMUNICATIONS. WE ARE ALREADY INCORPORATING SOME ELEMENTS OF SUCH A SYSTEM IN OUR NEW RESEARCH FACILITY IN CLINTON TOWNSHIP, NEW JERSEY.

OUR GOAL IS TO GO FAR BEYOND ROUTINE RESORT TO CANNED CAD AND CANNED CAM. IT IS TO ENHANCE THE SCOPE FOR PERSONAL INITIATIVE AND CREATIVITY. AND IT IS TO AVOID THE DANGER OF WHAT THE PHILOSOPHER, ALFRED NORTH WHITEHEAD, ONCE CALLED "THE FALLACY OF MISPLACED CONCRETENESS." SCIENTISTS AND ENGINEERS MUST NOT CONFUSE THE REALITY PROJECTED BY THE COMPUTER AND ITS PROGRAMS WITH REALITY ITSELF. CAD/CAM IS NOT THE SOURCE OF MODERN ENGINEERING EXCELLENCE. AS YOU WELL KNOW, THE REAL SOURCES ARE FUNDAMENTAL UNDERSTANDING OF MATERIALS AND PROCESSES, LEAVENED BY A KEEN AWARENESS OF HUMAN FACTORS.

FUNDAMENTAL MATHEMATICS MAY SERVE AS A GOOD EXAMPLE. MANY MATHEMATICIANS INSIST THAT ENGINEERS HAVE SCARCELY BEGUN TO TAP THE TREASURE OF NEW MATHEMATICAL RESOURCES ACCUMULATED SINCE WORLD WAR II. THIS KNOWLEDGE, ESPECIALLY AS ENGINEERS APPLY IT THROUGH BUILDING COMPUTER MODELS, MAY WELL PREPARE THEM PERCEIVE WHOLE NEW REALMS OF TECHNOLOGICAL OPPORTUNITY. FUNDAMENTAL MATHEMATICS HAS PERFORMED SUCH TRANSFORMATIONS TIME AND AGAIN. HERE, TOO, THE LESSON IS THAT THE BEST INDUSTRIAL POLICY IS TO ENHANCE HUMAN SKILLS AND INTELLIGENCE.

SUMMARY AND CONCLUSION

To sum up, these are suddenly volatile times for engineering education. As the presidential election year approaches the political noise level has increased to the point that it imperils what was once a growing national commitment to aid engineering education. As the politicians discard the discredited term "industrial policy," the threat is that they will throw out the baby with the bath water. That is not to say that there will not be plenty of action to support the various constituencies of science and technology. Rather, there may be too much unbalanced activity--expensive, vote-getting national projects that direct attention from the educational underpinnings of our science and technology. We will require clarion calls to preserve the balance both in Washington and in the states. That certainly means personal visits to your federal representatives and senators, with your very particular assessment of critical needs and opportunities. Even more importantly, it means talking to your <u>state</u> political representatives, and local business leaders. These people will listen most closely to you because they <u>are</u> local people. To describe how you should build these relationships would be the subject for another talk. One thing is certain: they will be highly specific to local personalities, institutions, and economies.

Yet despite the unsettled state of affairs, we can take heart from the marked shift away from the anti-technological bias of the seventies. The current American credo exhibits renewed

FAITH IN THE TRAINED TECHNICAL INTELLIGENCE. IN FACT THE NEW FILM, "THE RIGHT STUFF," SAYS EVEN MORE THAN THAT. IT SHOWS CHUCK YEAGER, JOHN GLENN, AND THE FIRST ASTRONAUTS IN A HEROIC LIGHT. WE LEARN THAT YOUNG ENGINEERS CAN BECOME POPULAR HEROES, AND EVEN PRESIDENTS. THE TIMES ARE FUNDAMENTALLY PROPITIOUS FOR CLARION CALLS. AND YOU HAVE "THE RIGHT STUFF" FOR MAKING THEM. I URGE YOU TO DO SO--AND I WISH YOU A MOST PRODUCTIVE CONFERENCE.

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